

What is claimed is:

1. A differential amplifier that receives first and second input signals and generates first and second output signals, the differential amplifier comprising:

5 a first differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input  
10 signal and generates a second differential output signal; and

a second differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second  
15 input signal and generates a fourth differential output signal;

wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by  
20 coupling the second differential output signal and the third differential output signal.

2. The differential amplifier according to claim 1, wherein the first and second differential output signals have  
25 reverse phases, and the third and fourth differential output signals have reverse phases.

3. The differential amplifier according to claim 1, wherein the first grounded emitter amplifier includes:

30 a first transistor,  
a first resistor connected between an emitter of the first transistor and a ground,  
a first capacitor connected to a base of the

first transistor, for receiving the first input signal, and  
a second resistor connected between the base of  
the first transistor and a bias voltage;

the first grounded base amplifier includes:

5 a second transistor,  
a second capacitor connected between a base of  
the second transistor and the ground,  
a third resistor connected between the base of  
the second transistor and the bias voltage,  
10 a third capacitor connected to an emitter of the  
second transistor, for receiving the first input signal, and  
a fourth resistor connected between the emitter  
of the second transistor and the ground;

the second grounded emitter amplifier includes:

15 a third transistor,  
a fifth resistor connected between an emitter of  
the third transistor and the ground,  
a fourth capacitor connected to a base of the  
third transistor, for receiving the second input signal, and  
20 a sixth resistor connected between the base of  
the third transistor and the bias voltage; and

the second grounded base amplifier includes:

a fourth transistor,  
a fifth capacitor connected between a base of the  
25 fourth transistor and the ground,  
a seventh resistor connected between the base of  
the fourth transistor and the bias voltage,  
a sixth capacitor connected to an emitter of the  
fourth transistor, for receiving the second input signal, and  
30 an eighth resistor connected between the emitter  
of the fourth transistor and the ground;  
wherein a collector of the first transistor is connected to a  
collector of the fourth transistor, and a collector of the

second transistor is connected to a collector of the third transistor.

4. The differential amplifier according to claim 1,  
5 wherein the first grounded emitter amplifier includes:

a first transistor, a base of which receives the first input signal, and

a first resistor connected between an emitter of the first transistor and a ground;

10 the first grounded base amplifier includes:

a second transistor,

a first capacitor connected between a base of the second transistor and the ground,

a third transistor, a collector of which is  
15 connected to an emitter of the second transistor, and a base of which is connected to its own collector and receives the first input signal, and

a second resistor connected between an emitter of the third transistor and the ground;

20 the second grounded emitter amplifier includes:

a fourth transistor, a base of which receives the second input signal, and

a third resistor connected between an emitter of the fourth transistor and the ground; and

25 the second grounded base amplifier includes:

a fifth transistor, a base of which is connected to the ground via the first capacitor,

a sixth transistor, a collector of which is connected to an emitter of the fifth transistor, and a base of which is connected to its own collector and receives the  
30 second input signal, and

a fourth resistor connected between an emitter of the sixth transistor and the ground;

wherein a collector of the first transistor is connected to a collector of the fifth transistor, and a collector of the second transistor is connected to a collector of the fourth transistor.

5

5. The differential amplifier according to claim 1, wherein the first grounded emitter amplifier includes:

a first transistor, a base of which receives the first input signal,

10 a first resistor connected between an emitter of the first transistor and a ground, and

a second transistor, an emitter of which is connected to a collector of the first transistor;

the first grounded base amplifier includes:

15 a third transistor,

a first capacitor connected between a base of the third transistor and the ground,

a fourth transistor, a collector of which is connected to an emitter of the third transistor, and a base of which is connected to its own collector and receives the first input signal, and

20 a second resistor connected between the emitter of the third transistor and the ground;

the second grounded emitter amplifier includes:

25 a fifth transistor, a base of which receives the second input signal, and

a sixth transistor, an emitter of which is connected to a collector of the fifth transistor; and

the second grounded base amplifier includes:

30 a seventh transistor, a base of which is connected to the ground via the first capacitor,

an eighth transistor, a collector of which is connected to an emitter of the seventh transistor, and a base

of which is connected to its own collector and receives the second input signal, and

a fourth resistor connected between an emitter of the eighth transistor and the ground;

- 5 wherein a collector of the second transistor is connected to a collector of the seventh transistor, and a collector of the third transistor is connected to a collector of the sixth transistor.

10 6. A differential converter comprising:

an input-stage differential converter including a first grounded emitter amplifier that receives an original input signal and generates a first differential input signal, and a first grounded base amplifier that receives the original  
15 input signal and generates a second differential input signal; and

- a differential amplifier connected to the input-stage differential converter, for receiving the first and second differential input signals and generating first and second  
20 output signals, wherein the differential amplifier includes:

a first output-stage differential converter including a second grounded emitter amplifier that receives the first differential input signal and generates a first differential output signal, and a second grounded base  
25 amplifier that receives the first differential input signal and generates a second differential output signal, and

- a second output-stage differential converter including a third grounded emitter amplifier that receives the second differential input signal and generates a third differential output signal, and a third grounded base  
30 amplifier that receives the second differential input signal and generates a fourth differential output signal, wherein the first output signal is generated by coupling the first

differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal.

5

7. A mixer that mixes first and second input signals with first and second carrier signals to generate first and second mixer output signals, the mixer comprising:

10 a differential amplifier that receives the first and second input signals and generates first and second output signals, wherein the differential amplifier includes,

15 a first differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal and a first grounded base amplifier that receives the first input signal and generates a second differential output signal;

20 a second differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal, wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal; and

25 a pair of differential circuits connected to the differential amplifier, for receiving the first and second output signals and the first and second carrier signals to  
30 generate the first and second mixer output signals.

8. A mixer that mixes an original input signal with first and second carrier signals to generate first and second

mixer output signals, the mixer comprising:

an input-stage differential converter including a first grounded emitter amplifier that receives the original input signal and generates a first differential input signal, and a first grounded base amplifier that receives the original input signal and generates a second differential input signal;

a differential amplifier connected to the input-stage differential converter, for receiving the first and second differential input signals and generating first and second output signals, wherein the differential amplifier includes,

a first output-stage differential converter including a second grounded emitter amplifier that receives the first differential input signal and generates a first differential output signal, and a second grounded base amplifier that receives the first differential input signal and generates a second differential output signal, and

a second output-stage differential converter including a third grounded emitter amplifier that receives the second differential input signal and generates a third differential output signal, and a third grounded base amplifier that receives the second differential input signal and generates a fourth differential output signal, wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal; and

a pair of differential circuits connected to the differential amplifier, for receiving the first and second output signals and the first and second carrier signals to generate the first and second mixer output signals.